NASA Langley's
Damage and Tamper Detection Sensor System

Wireless, powerless, passive SansEC sensors for determining damage to materials and structures, or for detecting tampering to packages

NASA Langley researchers have developed a wireless, connection-free inductor capacitor sensor system that can be placed on or embedded in materials and structures to monitor for and detect damage. The sensors can also be used to detect package tampering and pilfering. This innovation—SansEC [sans Electrical Connections]—makes sensors more damage resilient and more environmentally friendly to manufacture and use.

The sensors use a NASA award-winning magnetic field response measurement acquisition device to provide power to the sensors and to acquire physical property measurements from them. The sensors can be continuously or occasionally monitored to detect cracks, material strain, or impact damage. Damage location can also be readily identified with this system.

Benefits

- Receives power wirelessly, eliminating the need for a sensor power source
- Sends signals wirelessly to the data acquisition device, eliminating signal wiring
- Reduces system weight due to less wiring
- Eliminates risk of electrical arcing in explosive conditions
- Damage location is readily identified, helping to pinpoint areas for repair
- Reduces the number of electrical connections within the circuit, improving reliability
- Mass-producible, well suited for manufacture to a specific size
- Protected from environmental elements when placed inside a package or container
- One sensor can be used for multiple measurements, including biological decay and temperature

partnership opportunity

Applications

The technology offers wide-ranging market applications, including:

- Package tamper/pilfering detection
- Puncture detection in hazmat suits or other protective clothing
- Cracks or anomalies in composite vehicle structures
- Damage detection of multilayer materials

The Technology

The SansEC sensor system consists of multiple pairs of inductor-capacitor sensors with no electrical connections, which are placed throughout the material being monitored for damage. The sensors are embedded in or placed directly onto the surface of the material. Strains and breaks are detected by changes in resonant frequency read by the accompanying magnetic field data acquisition system. When pulsed by a sequence of magnetic field harmonics from the acquisition system, the sensors become electrically active and emit a wireless response. The magnetic field response attributes of frequency, amplitude, and bandwidth of the inductor correspond to the physical property states measured by the sensor. The received response is correlated to calibration data to determine the physical property measurement. Because each sensor pair has its own frequency response, when damage occurs to that circuit the frequency response changes. This change identifies the damage location within the material.

A unique feature achieved by eliminating electrical connections is that damage to a single point will not prevent the sensor from being powered or interrogated. If a sensor is broken, two concentric inductively coupled sensors are created, thus identifying tamper or damage location.

The low-profile sensor technology includes U.S. patent 7,231,832 and application 20070183110.

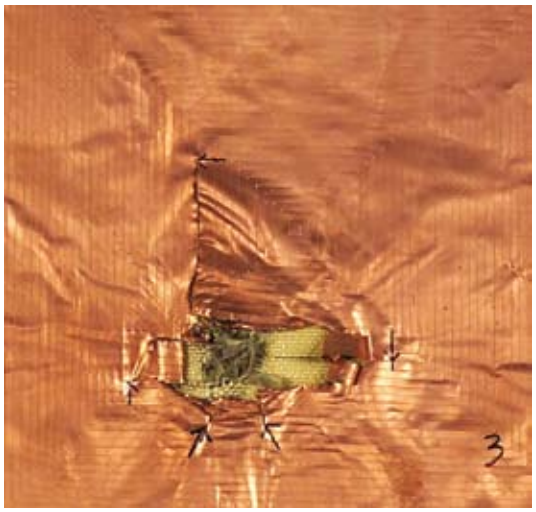

Figure 1: The sensor shown above was hit by a 3.2 mm projectile at approximately 15,000 mph. The resulting hole was 5.6 cm by 0.8 cm with a 4.6 cm rip. Though damaged, the sensor continued to operate.

For More Information

If your company is interested in licensing or joint development opportunities associated with this technology, or if you would like additional information on partnering with NASA, please contact:

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